

PARTIAL READ AND WRITE PATH DATA FLOW
IN A DIRECT ACCESS STORAGE DEVICE

FIG. 1
(Prior Art)

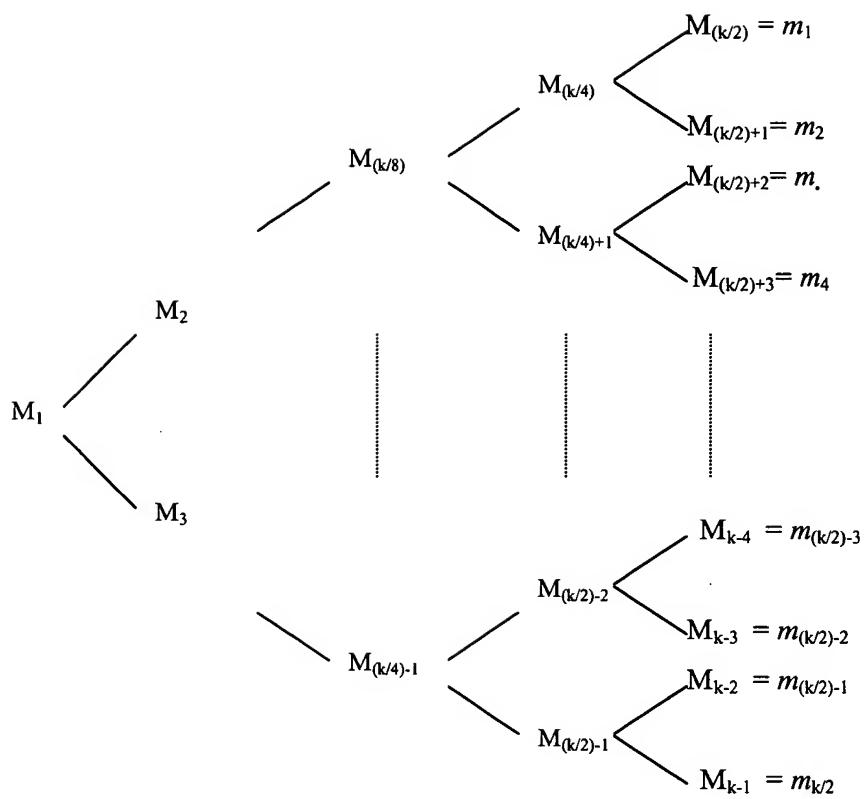


FIG. 2

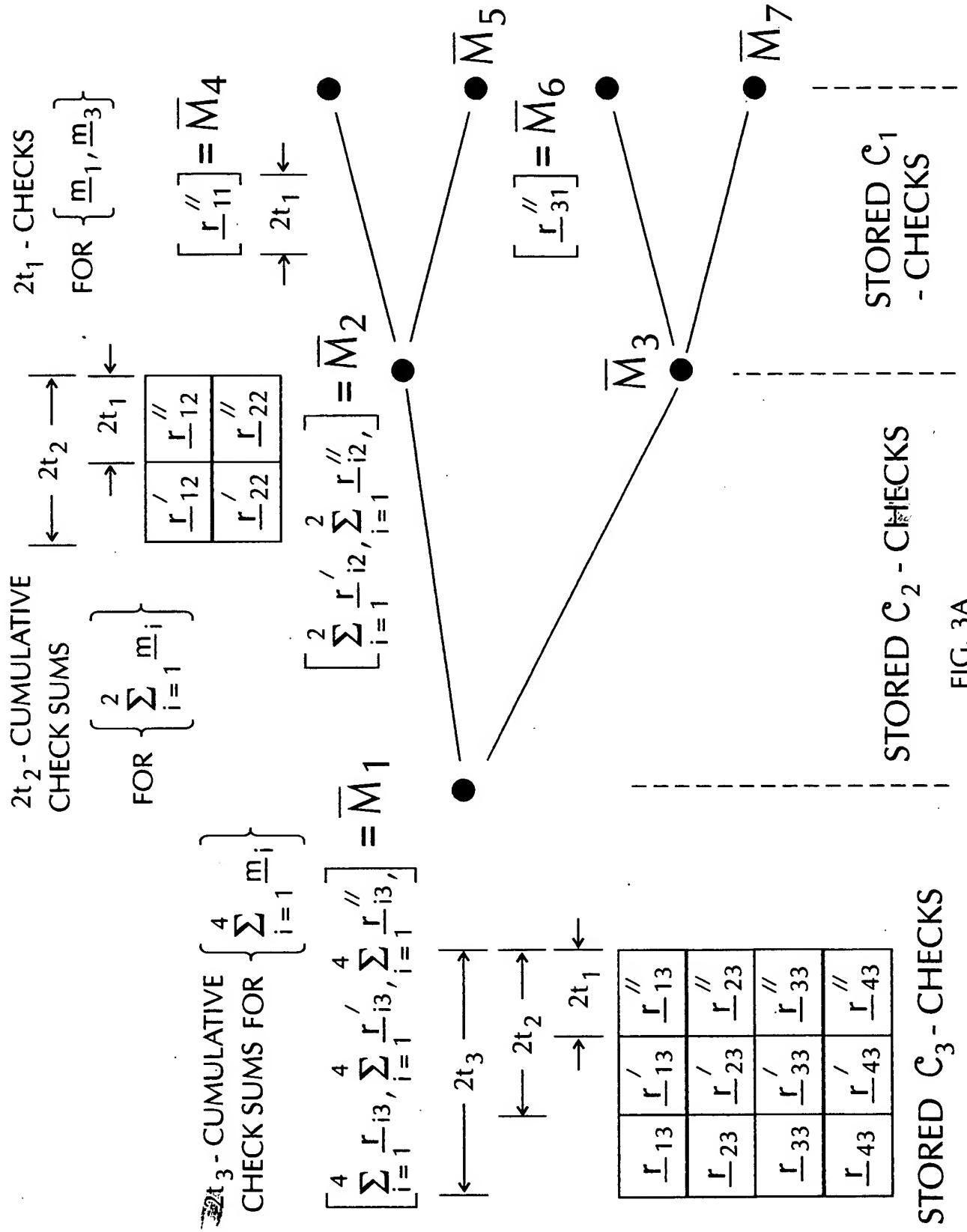


FIG. 3A

MULTI-LEVEL ENCODER

CHECK EQUATIONS

$$\overline{M}_4 = \boxed{\underline{r}_{11}''}$$

$$\underline{r}_1 \Rightarrow \boxed{\underline{m}_1 \quad \underline{r}_1}$$

$$\boxed{\sum_{i=1}^2 \underline{r}'_{i2} \quad \sum_{i=1}^2 \underline{r}''_{i2}}$$

$$\underline{r}_a \quad \underline{r}_2 \Rightarrow \boxed{\underline{m}_2 \quad \underline{r}_a \quad \underline{r}_2}$$

$$\boxed{\underline{r}_{31}''}$$

$$\underline{r}_3 \Rightarrow \boxed{\underline{m}_3 \quad \underline{r}_3}$$

$$\boxed{\sum_{i=1}^4 \underline{r}'_{i3} \quad \sum_{i=1}^4 \underline{r}''_{i3}}$$

$$\underline{r}_c \quad \underline{r}_b \quad \underline{r}_4 \Rightarrow \boxed{\underline{m}_4 \quad \underline{r}_c \quad \underline{r}_b \quad \underline{r}_4}$$

\underline{m}_1	\underline{r}_1	\underline{m}_2	\underline{r}_a	\underline{r}_2	\underline{m}_3	\underline{r}_3	\underline{m}_4	\underline{r}_c	\underline{r}_b	\underline{r}_4
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$$\underline{C}_4 \subset \underline{C}_1$$

$$\underline{C}_1 \subset \underline{C}_1$$

$$\underline{C}_2 \subset \underline{C}_1$$

$$\underline{C}_3 \subset \underline{C}_1$$

$$\frac{\underline{C}_1 + \underline{C}_2 \subset \underline{C}_1}{\underline{C}_1 + \underline{C}_2 + \underline{C}_3 + \underline{C}_4 \subset \underline{C}_1} \quad \underline{C}_3 + \underline{C}_4 \subset \underline{C}_2 \subset \underline{C}_1$$

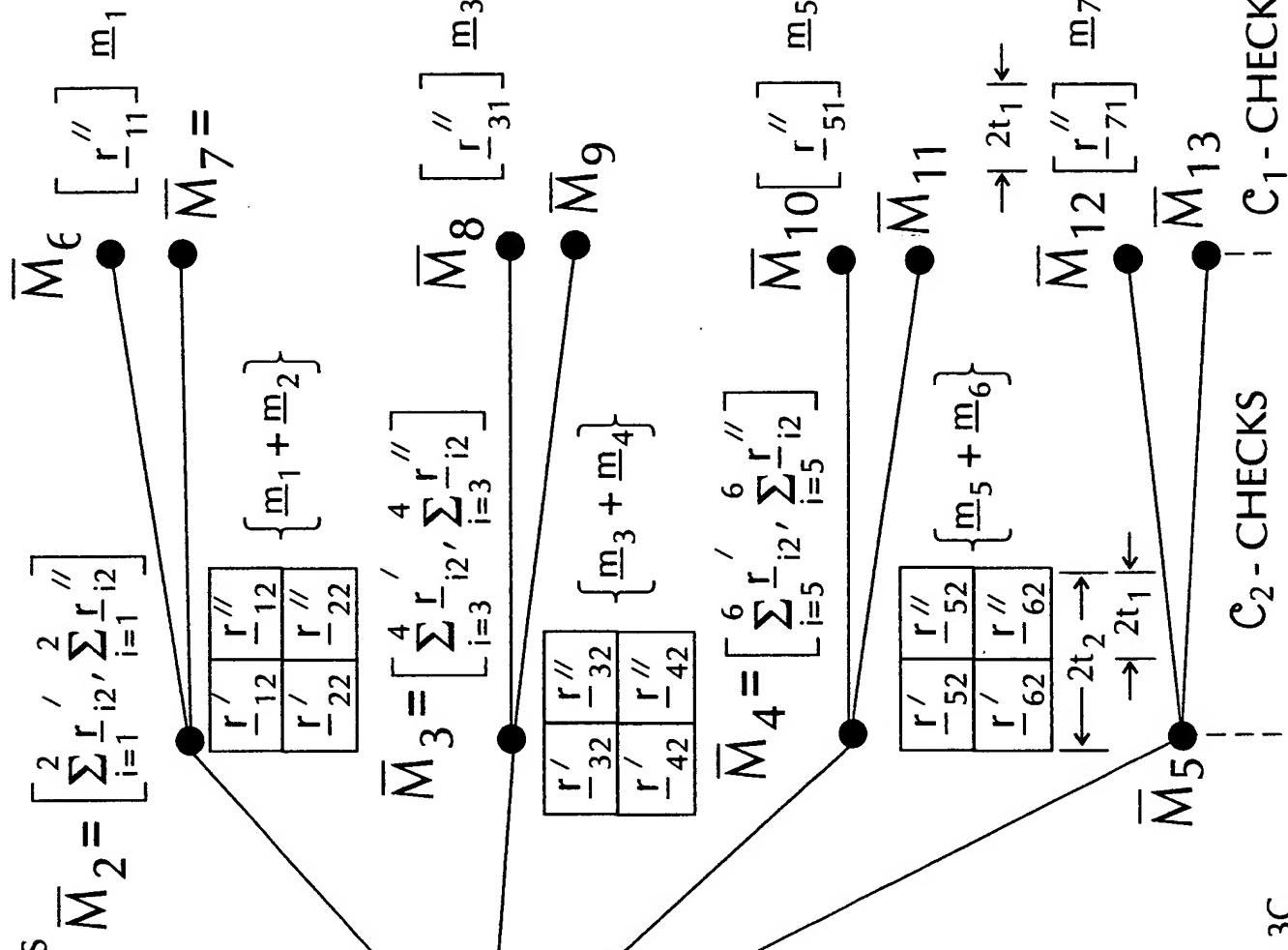
**INTEGRATED
4-SECTOR
FORMAT**

FIG. 3B

2t₂ - CUMULATIVE CHECK SUMS

$$\bar{M}_2 = \left[\sum_{i=1}^2 r'_{i2}, \sum_{i=1}^2 r''_{i2} \right] \quad \bar{M}_1 = \left[\sum_{i=1}^8 r'_{i3}, \sum_{i=1}^8 r''_{i3} \right]$$

2t₃ - CUMULATIVE SYNDROME SUMS FOR $\left\{ \sum_{i=1}^8 m_i \right\}$



C₃-CHECKS

FIG. 3C

C₂-CHECKS

C₁-CHECKS

MULTI-LEVEL ENCODER CHECK EQUATION

$$\begin{aligned}
 M_6 &= \left[\begin{matrix} r_{11}'' \\ r_{31}'' \end{matrix} \right] & M_8 &= \left[\begin{matrix} r_{31}'' \\ r_{51}'' \end{matrix} \right] & M_{10} &= \left[\begin{matrix} r_{51}'' \\ r_{71}'' \end{matrix} \right] \\
 \underline{C_1} \downarrow & \underline{C_2} \downarrow & \underline{C_3} \downarrow & \underline{C_4} \downarrow & \underline{C_5} \downarrow & \underline{C_6} \downarrow \\
 \boxed{\frac{m_1}{r_1}} & \boxed{\frac{r_1}{r_2}} & \boxed{\frac{r_{a_1}r_2}{r_3}} & \boxed{\frac{r_2}{r_3}} & \boxed{\frac{m_3}{r_3}} & \boxed{\frac{r_3}{r_4}} \\
 & & & & & \boxed{\frac{m_4}{r_4}} \boxed{\frac{r_{a_3}r_4}{r_5}} \boxed{\frac{r_4}{r_5}} \\
 & & & & & \boxed{\frac{m_5}{r_5}} \boxed{\frac{r_5}{r_6}} \boxed{\frac{m_6}{r_6}} \boxed{\frac{r_6}{r_7}} \\
 & & & & & \boxed{\frac{m_7}{r_7}} \boxed{\frac{r_7}{r_8}} \boxed{\frac{m_8}{r_8}} \boxed{\frac{r_8}{r_1}}
 \end{aligned}$$

$$\begin{aligned}
 M_2 + M_6 &= \left\{ \sum_{i=1}^2 \frac{r_i''}{r_{i2}} + \frac{r_1}{r_1} \right\} \\
 M_3 + M_8 &= \left\{ \sum_{i=3}^4 \frac{r_i'}{r_{i2}} \right\} \\
 M_4 + M_{10} &= \left\{ \sum_{i=5}^6 \frac{r_i'}{r_{i2}} + \frac{r_5}{r_5} \right\} \\
 M_{12} &= \left\{ \sum_{i=7}^8 \frac{r_i''}{r_{i2}} + \frac{r_7}{r_7} \right\}
 \end{aligned}$$

$\underline{C_1} + \underline{C_2} \subset C_2$	$\sum_{i=1}^8 r_{i3}$
$\underline{C_3} + \underline{C_4} \subset C_2$	$\sum_{i=1}^8 r'_{i3} + \frac{r_{a_{12}}}{r_{a_{34}}} + \frac{r_{a_{56}}}{r_{a_{56}}}$
$\underline{C_5} + \underline{C_6} \subset C_2$	$\sum_{i=1}^8 r''_{i3} + \underline{r_1} + \underline{r_2} + \underline{r_3} + \underline{r_4} + \underline{r_5} + \underline{r_6} + \underline{r_7}$
$\underline{C_7} + \underline{C_8} \subset C_2$	
$\sum_{i=1}^8 C_i \subset C_3$	

INTEGRATED 8-SECTOR FORMAT

$$C_3 \subset C_2 \subset C_1$$

FIG. 3D

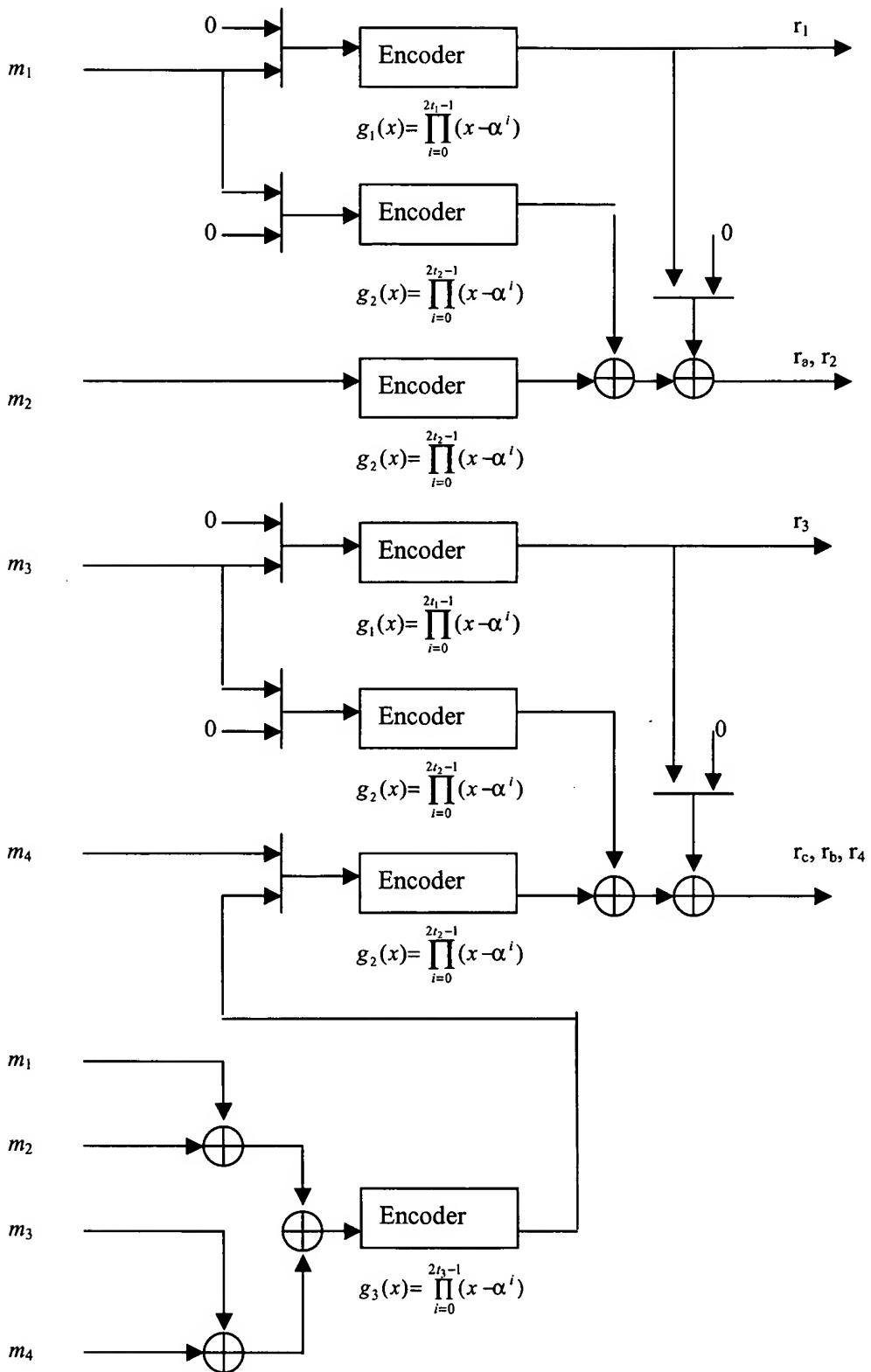


FIG. 4

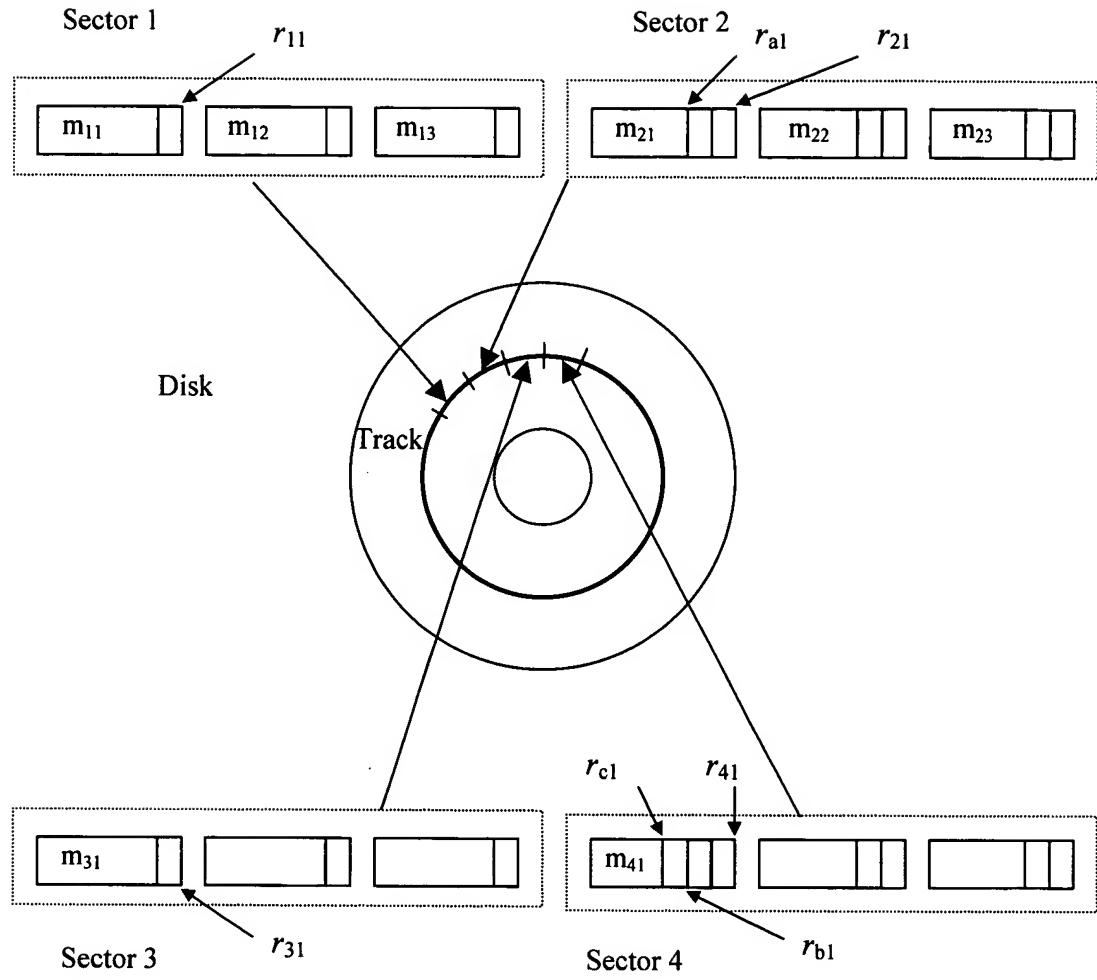


FIG. 5

MULTI-LEVEL SYNDROME GENERATOR

$2t_2$ - CUMULATIVE
SYNDROME SUMS FOR

$$\bar{M}_2 = \left[\sum_{i=1}^2 \underline{S}'_{i2}, \sum_{i=1}^2 \underline{S}''_{i2} \right], \sum_{i=1}^2 \underline{\tilde{C}}_i$$

$2t_3$ - CUMULATIVE
SYNDROME SUMS FOR

$$\sum_{i=1}^4 \underline{\tilde{C}}_i$$

$$\begin{aligned} & \left[\underline{S}'_{12}, \underline{S}''_{12} \right] \\ & \left[\underline{S}'_{22}, \underline{S}''_{22} \right] \end{aligned}$$

$$\begin{aligned} & \left[\sum_{i=1}^4 \underline{S}'_{i3}, \sum_{i=1}^4 \underline{S}''_{i3} \right] = \bar{M}_1 \\ & \left[\underline{S}_{13}, \underline{S}'_{13}, \underline{S}''_{13} \right] \\ & \left[\underline{S}_{23}, \underline{S}'_{23}, \underline{S}''_{23} \right] \\ & \left[\underline{S}_{33}, \underline{S}'_{33}, \underline{S}''_{33} \right] \\ & \left[\underline{S}_{43}, \underline{S}'_{43}, \underline{S}''_{43} \right] \end{aligned}$$

$2t_1$ SYNDROMES FOR

$2t_2$ - CUMULATIVE
SYNDROME SUMS FOR

$$\bar{M}_2 = \left[\sum_{i=1}^2 \underline{S}'_{i2}, \sum_{i=1}^2 \underline{S}''_{i2} \right], \sum_{i=1}^2 \underline{\tilde{C}}_i$$

$$\begin{aligned} & \left[\underline{S}'_{12}, \underline{S}''_{12} \right] \\ & \left[\underline{S}'_{22}, \underline{S}''_{22} \right] \end{aligned}$$

$$\bar{M}_3 = \left[\sum_{i=3}^4 \underline{S}'_{i2}, \sum_{i=3}^4 \underline{S}''_{i2} \right], \sum_{i=3}^2 \underline{\tilde{C}}_i$$

$$\begin{aligned} & \left[\underline{S}'_{32}, \underline{S}''_{32} \right] \\ & \left[\underline{S}'_{42}, \underline{S}''_{42} \right] \end{aligned}$$

$$\bar{M}_4 = \left[\underline{S}'_1, \underline{S}''_1 \right], \underline{\tilde{C}}_1$$

$$\bar{M}_5 = \left[\underline{S}'_2, \underline{S}''_2 \right], \underline{\tilde{C}}_2$$

$$\bar{M}_6 = \left[\underline{S}'_3, \underline{S}''_3 \right], \underline{\tilde{C}}_3$$

$$\bar{M}_7 = \left[\underline{S}'_4, \underline{S}''_4 \right], \underline{\tilde{C}}_4$$

STORED C_2
- SYNDROMES

STORED C_1
- SYNDROMES

STORED C_3
- SYNDROMES

FIG. 6

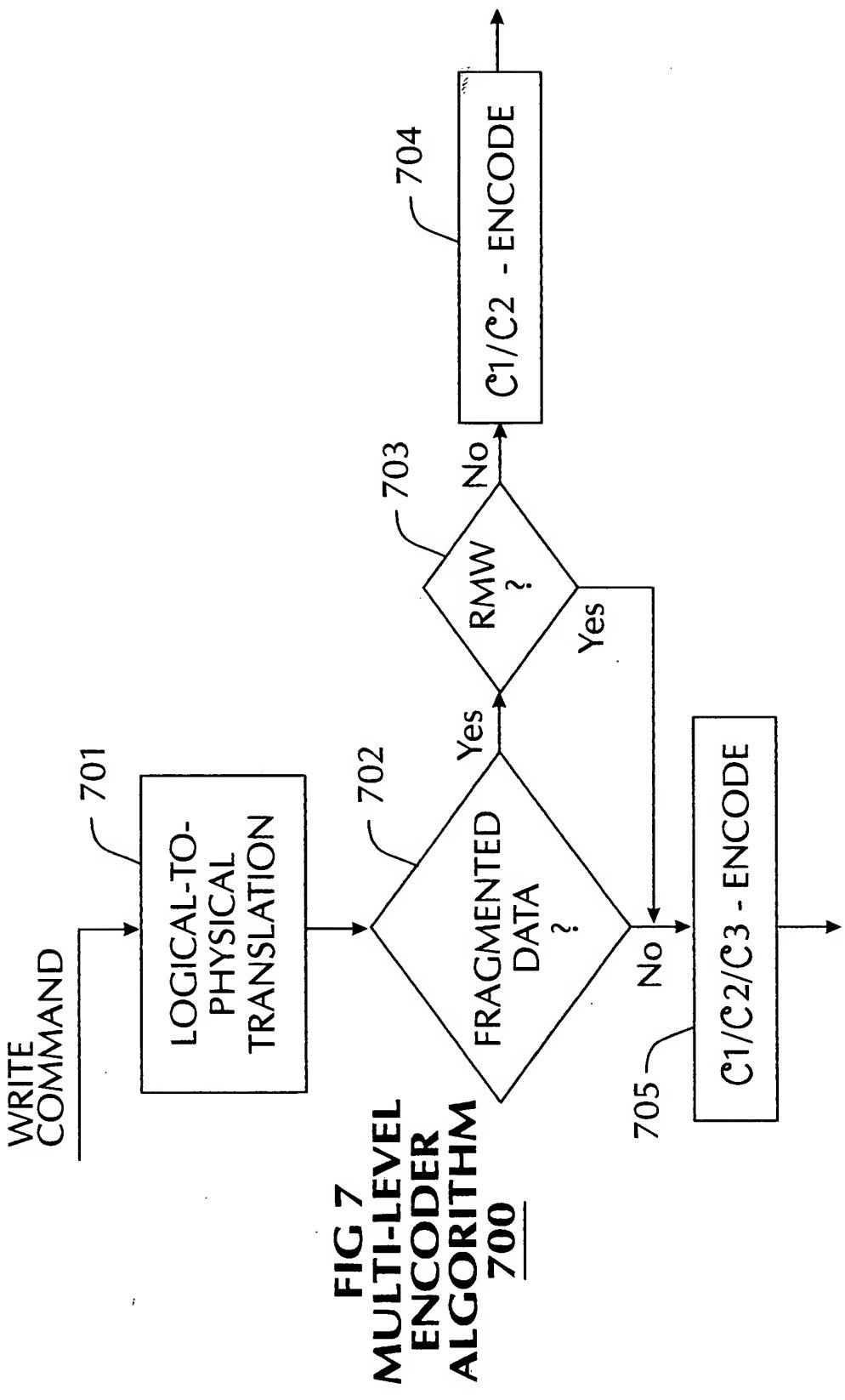


FIG. 8
MULTI-LEVEL
DECODER
ALGORITHM
800

